Post-Impoundment Declines in Catch and Market Quality in the Winter Commercial Whitefish Fishery, Southern Indian Lake, Manitoba

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POST-IMPOUNDMENT DECLINES IN CATCH AND MARKET QUALITY IN THE WINTER COMMERCIAL WHITEFISH FISHERY, SOUTHERN INDIAN LAKE, MANITOBA

by

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ABSTRACT

Bodaly, R.A., T.W.D. Johnson, and R.J.P. Fudge. 1983. Post-impoundment declines in catch and market quality in the winter commercial whitefish fishery, Southern Indian Lake, Manitoba. Can. Manuscr. Rep. Fish. Aquat. Sci. 1685: iv + 9 p.

Significant changes in the catch and market quality of the commercial whitefish (Coregonus clupeaformis) catch from Southern Indian Lake, Manitoba since lake impoundment and Churchill River diversion have been previously documented for the summer fishery. This report extends those observations to the winter commercial fishery. Prior to impoundment, the winter catch was composed almost entirely of light colored export (#1) quality fish. Dark colored, lower quality fish have comprised from 12 to 51% of the winter catch since lake impoundment in 1976. The mean whitefish catch per unit of effort on traditional fishing grounds declined from 18.5 kg/net/night before impoundment in 1972-73 to 4.2 kg/net/night after impoundment in 1980-81, and was somewhat higher (5.6 kg/net/night) in 1981-82. Prior to flooding, all fishing activity was located on traditional fishing grounds, south of Sand Point, whereas in 1980-81, 30% of fishing effort was expended north of Sand Point.

Key words: whitefish, lake; fisheries; freshwater fish; commercial grade; reservoirs (water); impoundment; river diversion; Triaenophorus.

RESUME

Bodaly, R.A., T.W.D. Johnson, and R.J.P. Fudge. 1983. Post-impoundment declines in catch and market quality in the winter commercial whitefish fishery, Southern Indian Lake, Manitoba. Can. Manuscr. Rep. Fish. Aquat. Sci. 1685: iv + 9 p.

Les données relatives à la pêche d'été ont permis de noter des modifications appréciables de l'importance et de la qualité des prises commerciales de grands corégones (Coregonus clupeaformis) dans le Southern Indian Lake (Manitoba) suite à la transformation du lac en réservoir et à la dérivation de la Churchill River. Le présent rapport traite des données relatives à la pêche commerciale d'hiver. Les prises d'hiver étaient presque exclusivement représentées par des poissons de coloration pâle de catégorie #1 (Export) avant la construction du barrage de retenue en 1976. Depuis lors, les prises d'hiver ont été composées de poissons de coloration foncée de catégorie inférieure dans une proportion de 12 à 51%. Les prises de grands corégones par effort de pêche dans les aires de pêche traditionnelles sont passées de 18,5 kg par filet et par nuit en 1972-73, avant la construction du barrage, à 4,2 kg par filet et par nuit en 1980-81, après la construction, et à une valeur légèrement supérieure (5,6 kg par filet par nuit) en 1981-82. Avant l'inondation des terres, toute la pêche était effectuée dans les aires traditionnelles au sud de Sand Point tandis qu'en 1980-81, 30% de la pêche était effectuée au nord de Sand Point.

Mots-clés: grand corégone, pêche commerciale; poisson d'eau douce; catégorie commerciale; réservoirs (d'eau); barrage de retenue, dérivation de cours d'eau, Triaenophorus.

INTRODUCTION

Significant problems in the summer commercial whitefish (Coregonus clupeaformis) fishery on Southern Indian Lake, Manitoba since lake impoundment in 1976 have been previously documented (MacLaren 1978; Bodaly et al. 1980, 1983; Bodaly et al., in prep.). Whitefish catch per unit of effort on traditional fishing grounds in the summers of 1979, 1980 and 1981 declined to 61, 46 and 33% of the pre-impoundment mean in 1972 (Bodaly et al. 1980, 1983, Bodaly et al., in prep.). Major shifts of fishing effort from traditional areas (south of Sand Point) to non-traditional areas (north of Sand Point) resulted in a high proportion of dark colored, lower quality whitefish harvests since impoundment. Catches from areas north of Sand Point were composed exclusively of dark colored whitefish. Dark colored whitefish were of lower commercial value than light whitefish because of external coloration and higher Triaenophorus crassus cyst infestation. The proportion of summer fishing effort expended north of Sand Point from 1979 to 1981 was 62, 30 and 33% respectively, resulting in 72, 34 and 81% respectively of whitefish production being dark colored (Bodaly et al. 1980, 1983; Bodaly et al., in prep.). The decline in catch per unit effort and the shift in the location of much of the fishing effort resulted in increased costs and effort to commercial fishermen.

The purpose of this study was: (1) to determine whether changes in catch per unit of effort, market quality and effort in the winter fishery were similar to changes in the summer fishery, (2) to determine the magnitude of these changes, and (3) to provide data to assist in tme formulation of compensation plans. The pre-impoundment winter fishery of 1972-1973 will be compared with the post-impoundment fishery of 1980-1981. A limited amount of data from the 1981-82 winter fishery will also be presented.

MATERIALS AND METHODS

STUDY AREA

Southern Indian Lake (SIL) is located in north-central Manitoba (57°N, 99°W) on the Churchill River. SIL is the 21st largest lake in Canada, with a pre-flooding surface area of 1,977 km^2 and a post-flooding surface area of 2,391 km^2 (McCullough 1981). The lake was flooded in 1976 and the flow of the Churchill River through the lake was diverted in 1977 as part of the Churchill and Nelson Rivers hydroelectric development. Prior to development, the Churchill River flushed most basins of the lake. The natural outlet of the lake was dammed, the level of the lake was raised by 3 m above the former long term mean and 80% of the flow of the Churchill River was diverted into the Nelson River basin through an artificial channel (Fig. 1). The post-flooding mean depth is 10 m, while pre-flooding mean depth was 9 m (McCullough 1981).

The Southern Indian Lake commercial fishery has been a large, highly productive whitefish fishery since its inception in the winter of 1941-42. Whitefish has been the single most important commercial species in the winter fishery. Whitefish have accounted for an average of 95% (by weight) of shipments from the winter fishery between 1941-42 and 1971-72 (Weagle and Baxter 1973) and 90% over the period of 1970-78 (Fishing and Industry Services, DFO). The winter fishing season accounted for about 15% by weight of the total catch over the period 1970-1979 inclusive, with the summer season accounting for the 85% majority.

DATA COLLECTION

Fishing effort and locations of fishing were determined by interviews with commercial fishermen. Fishermen were asked for fishing locations, number of nets set and duration of set. Data was recorded by fishing enterprise whether an enterprise comprised two or more licensed fishermen or licensed fisherman plus helper(s). Sampling bias was probably small because there were no refusals to provide information by fishing enterprises contacted. Approximately 45% of the lake-wide whitefish fishing effort (calculated by dividing the total lake catch by an estimate of the overall catch per unit of effort) was sampled. One fishing period (usually one or two days) of one fishing enterprise, for which information on the day of net setting, number of nets set, day of net lifting and catch were available, was used as a single data point for the calculation of catch per unit of effort and other parameters. The methods of data collection in 1980-81 were similar to those used in 1972-73 by Weagle and Baxter (1973).

In the winter fishery, fish were caught exclusively by gill nets set beneath the ice. A standard net of 13.3 cm (5 1/4 in) stretched mesh and 91.4 m (100 yd) in length was used in the lake whitefish fishery. Daily catches for individual fishing enterprises were recorded from Freshwater Fish Marketing Corporation (FFMC) weekly fishermen's tickets. Lake whitefish landed at Loon Narrows packing plant were sorted according to size (small, medium, large or jumbo) and external coloration (light or dark) by FFMC personnel. Shipments destined for export to United States markets were sampled by Fisheries and Oceans inspectors for Triaenophorus crassus cyst infestation at the Winnipeg FFMC plant.

RESULTS

GEOGRAPHIC DISTRIBUTION OF FISHING EFFORT

Fishing effort for the 1972-73 winter fishing season was concentrated exclusively south of Sand Point (Fig. 2) (Weagle and Baxter 1973). During this season 2,630 net nights of effort were sampled, all of which were expended south of Sand Point. The location of fishing effort in the 1980-81 winter fishery changed from 1972-73. A total effort of 3,316 net nights were sampled in 1980-81, of which 2,326 net nights (70%) was expended south of Sand Point while 990 net nights (30%) of the total sampled effort was expended north of Sand Point

(Fig. 3). In winter 1981-82, 76% of the effort sampled (1,245 of 1,643 net nights) was expended north of Sand Point.

CATCH PER UNIT OF EFFORT

The mean catch per unit of effort (CPE) of whitefish for fishing enterprises landing fish at Loon Narrows during the winter of 1972-73 was 18.5 kg/net/night (Weagle and Baxter 1973; Fig. 4). All of this sampled effort was expended on traditional fishing grounds south of Sand Point (Fig. 2). Mean whitefish CPE for fishing enterprises landing fish at Loon Narrows during the winter of 1980-81 was 4.2 kg/net/night (Fig. 4). Whitefish CPE was quite similar for areas north and south of Sand Point (mean CPE south of Sand Point: 4.2 kg/net/night; mean CPE north of Sand Point: 4.6 kg/net/ngiht). In 1981-82 a small sample of fishing enterprises operating from mid-February to late April (1643 net nights) yielded a mean whitefish CPE of 3.8 kg/net/night for areas both north and south of Sand Point.

MARKET QUALITY OF THE CATCH

Prior to lake impoundment, commercial shipments of whitefish from the Southern Indian Lake winter fishery were comprised almost exclusively of light colored, export quality (#1 grade) fish. Commercial shipments of whitefish showed a change in quality in the 1976-77 winter season when 12% of landings were of darker colored, second grade fish (Table 1). The proportion of dark whitefish in the post-impoundment winter catch has varied from 8-51% (Table 1).

Prior to impoundment in 1976, the average cyst counts in whitefish shipments from the winter fishery sampled by Canada Department of Fisheries inspectors was below 30 cysts per 45 kg dressed weight (Table 2). Since impoundment, mean cyst counts have ranged from 33-49 cysts per 45 kg as compared to the dividing line between Export and Continental grade of 40 cysts per 45 kg. Sampling of commercial shipments is not random but the changes observed in mean cyst counts may be interpreted as an indication of a change in the overall grade of the catch.

FREQUENCY OF NET RELOCATION

In the winter fishery of 1972-73 fishing enterprises usually set all nets in one location and did not relocate them frequently. Only one of the 13 fishing enterprises sampled in 1972-73 had nets set at more than one site at the same time. The mean number of days nets were left set in the same location in 1972-73 was 17 days (n = 23; range 2-31; s.d. = 8.1). In 1980-81, most fishing enterprises tended to set some of their nets in one location and the rest in one or more different locations. The average number of different sites utilized at a time by fishing enterprises in 1980-81 was 2.3 (n = 14; range 1-7; s.d. = 1.9). The mean number of days nets were left set in the same location in 1980-81 was only slightly less than in 1972-73 (x = 13.6 days; n = 12; range = 3-23; s.d. = 6.44; t = 1.3, no significant difference between years).

NUMBER OF NETS FISHED AND POUNDAGE PER DELIVERY

In 1972-73, fishing enterprises fished an average of 5.8 nets at a given time (n = 180, range = 2-12; s.d. = 2.7). In 1980-81, the number of nets fished per fishing enterprise increased dramatically to an average of 28.8 (n = 66; range 10-56; s.d. = 14.0).

In the winter fishery of 1972-73, fishing enterprises delivered an average of 151.5 kg per delivery (Weagle and Baxter 1973). In the winter fishery of 1980-81, fishing enterprises delivered an average of 72.1 kg per delivery (FFMC data) or 48% of 1972-73 deliveries.

DISCUSSION

The results presented in this report demonstrate that significant changes in the characteristics of the Southern Indian Lake winter whitefish fishery have taken place since lake impoundment. Catch per unit of effort (CPE) has decreased markedly and fishermen have responded with changes in the geographic distribution of fishing effort, an increase in the number of nets fished and other changes in fishing strategy. A significant proportion of fishing effort after lake impoundment was expended north of Sand Point, outside of traditional fishing areas. The areas north of Sand Point were avoided prior to flooding because they produced darker colored, more highly infested, lower quality whitefish catches (MacLaren 1978; Bodaly et al. 1980) and the post-impoundment changes in the geographic distribution of fishing effort have resulted in a catch composed of a significant proportion of lower quality fish.

These changes in the post-impoundment winter fishery are similar in magnitude to those which have been documented for the summer fishery (Bodaly et al. 1980, 1983; Bodaly et al., in prep.). The decrease in whitefish CPE appears to be more severe in the winter as compared to the summer fishery, perhaps partly due to the pattern of whitefish CPE prior to impoundment (Fig. 4). Fishing in areas north of Sand Point was quite attractive to fishermen in the summer fishery because of 16-36% higher whitefish CPE, shallower water and shorter wind fetches than on traditional fishing grounds. These factors appear to be less important in the winter fishery. Whitefish CPE was only about 10% higher north of Sand Point in 1980-81 and water depths and wind fetches are less important in the winter fishery than in the summer fishery. Therefore, the proportion of fishing effort expended outside of traditional fishing areas has been less in the winter fishery than in the summer fishery and no time or poundage restrictions have been agreed upon for winter fishing north of Sand Point to reduce the proportion of lower grade fish.

It has been hypothesized that the recent declines in whitefish CPE observed in the Southern Indian Lake fishery were due to stock redis-

tributions triggered by lake impoundment (Bodaly et al. 1980; Bodaly et al., in prep.). There is no evidence of effects of overfishing in the whitefish population such as a declining age distribution (Bodaly et al., in prep.).

The declines in the catches and grade of the winter whitefish fishery documented here have resulted in increased effort and expenses for commercial enterprises attempting to maintain catches at pre-impoundment levels. As a response to decreased CPE, fishing enterprises are utilizing higher effort. Prior to impoundment, net gangs were generally strung together as a unit, but after lake impoundment, nets were divided into smaller gangs and set in more than one location, in an effort to locate higher catches. The setting of net gangs under the ice in winter involves considerable time and effort. Also, nets were often located further distances from the Loon Narrows packing plant in 1980-81 than in 1972-73, necessitating longer delivery trips from fishing locations. Between 1972-73 and 1980-81, the average weight of fish per delivery decreased by about one half. During the winter fishery, fish must be either delivered immediately or buried in the snow to prevent freezing. In 1980-81, fishing enterprises were forced to take turns transporting fish to the Loon Narrows plant because production was too low to justify individual deliveries. Also, post-impoundment debris has increased the time and effort required to clear fish from nets. Compensation agreements between the commercial fishermen and the public utility involved, Manitoba Hydro, have attempted to address these problems in the commercial fishery.

ACKNOWLEDGMENTS

The continued support of the commercial fishermen of Southern Indian Lake is greatly appreciated. This study would not have been possible without their cooperation. We also thank G. A. Lawson and C. J. Hrenchuk for assistance in the field.

REFERENCES

BODALY, R.A., T.W.D. JOHNSON and R.J.P. FUDGE. 1980. Post-impoundment changes in commercial fishing patterns and catch of lake whitefish (Coregonus clupeaformis) in Southern Indian Lake, Manitoba. Can. Manuscr. Rep. Fish. Aquat. Sci. 1555: iv + 14 p.

BODALY, R.A., T.W.D. JOHNSON and R.J.P. FUDGE. In prep. Post-impoundment declines in the grade of the commercial whitefish catch from Southern Indian lake, northern Manitoba. Can. J. Fish. Aquat. Sci.

BODALY, R.A., T.W.D. JOHNSON and R.J.P. FUDGE. 1983. The post-impoundment commercial whitefish fishery of Southern Indian Lake, Manitoba: summer 1980 and 1981 results. Can. Manuscr. Rep. Fish. Aquat. Sci. 1686: iv + 14 p.

MacLAREN, J.F., Ltd. 1978. Report to Manitoba Hydro on changes in quality of whitefish fishery on Southern Indian Lake. May 1978.

McCULLOUGH, G.K. 1981. Water budgets for Southern Indian Lake, before and after impoundment and Churchill River diversion, 1972-79. Can. Manuscr. Rep. Fish. Aquat. Sci. 1620: iv + 22 p.

WEAGLE, K.V. and W. BAXTER. 1973. The fisheries of Southern Indian Lake. Exploitation and reproduction. Lake Winnipeg, Churchill and Nelson Rivers Study Board, Tech. Rep., App. 5, Vol. 1. 163 p.

Table 1. Proportion for export quality (light colored) and continental quality (dark colored) lake whitefish and total whitefish poundage in the winter commercial catch, Southern Indian Lake, 1972-73 to 1980-81. Data from Economics Branch, Fisheries and Oceans, Winnipeg, Manitoba.

Season	Total catch (dressed wt) (kg)	% Export (#1) quality	% Continental (#2) quality
1972-73	108,800	100	0
1973-74	12,400	100	0
1974-75	lake not fished	-	-
1975-76	50,700	100	0
1976-77	94,000	100*	0*
1977-78	23,400	100*	0*
1978-79	30,100	81	19
1979-80	43,100	92	8
1980-81	30,900	49	51

* Almost all lake whitefish were classified as export in 1976 and 1977 regardless of actual color. The actual proportion of dark colored fish was 12% and 20% in the winter seasons of 1976-77 and 1977-78 respectively.

Table 2. *Triaenophorus crassus* cyst levels in winter whitefish shipments from Southern Indian Lake, Manitoba, 1972-73 to 1980-81 (Industry Services Branch data, Fisheries and Oceans, Winnipeg, Manitoba).

Season	Mean rate of infestation (cysts per 45.4 kg dressed wt)	Range	Number of samples
1972-73	20.0	-	1
1973-74	16.7	0-25.0	3
1974-75	lake not fished	-	-
1975-76	23.7	20.0-33.3	6
1976-77	33.9	33.3-34.4	2
1977-78	32.9	0-73.3	12
1978-79	44.5	25.0-125.0	15
1979-80	41.9	0-81.8	18
1980-81	48.8	20.0-180.0	13

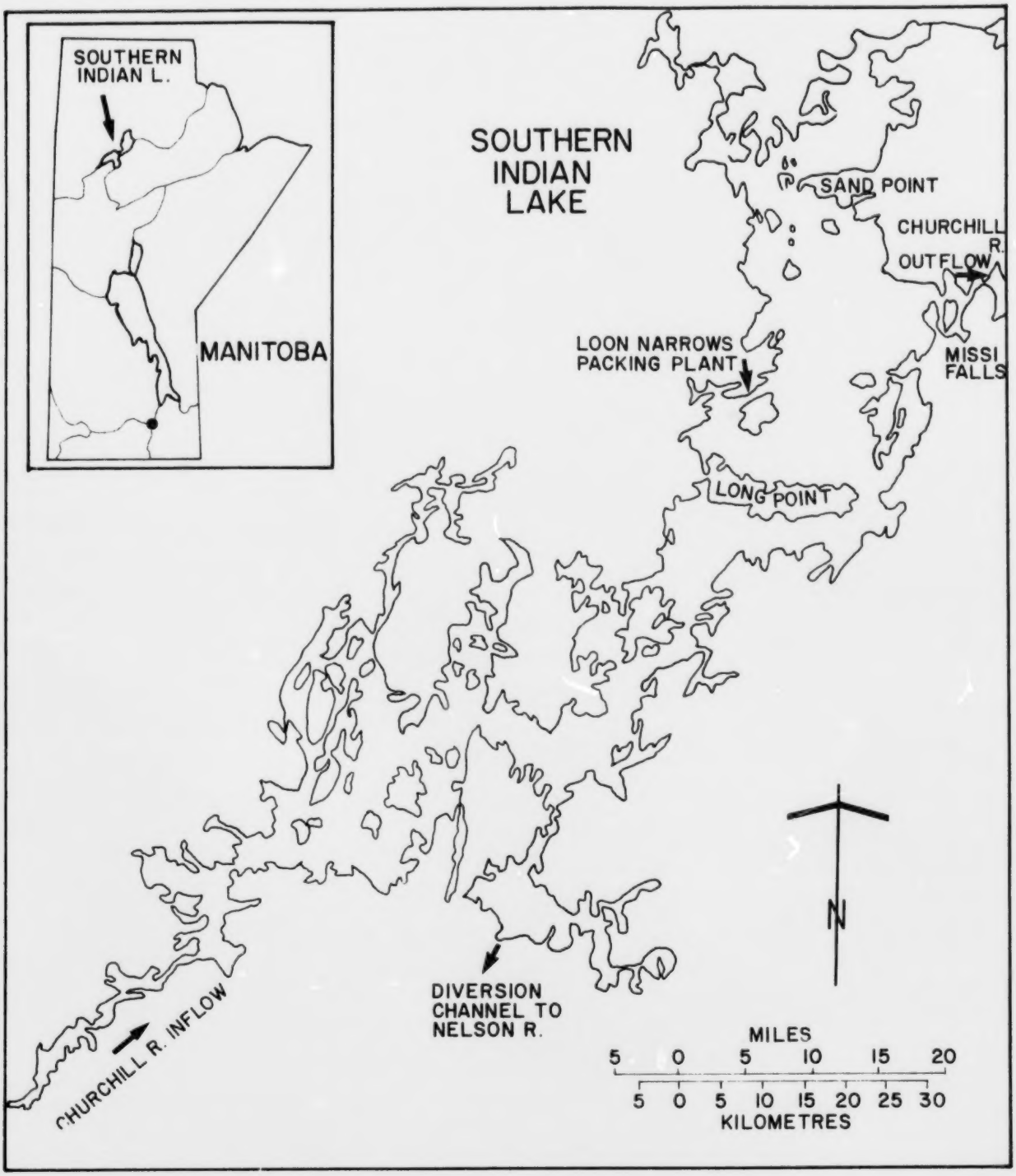

Fig. 1. Map of study area showing Loon Narrows packing plant.

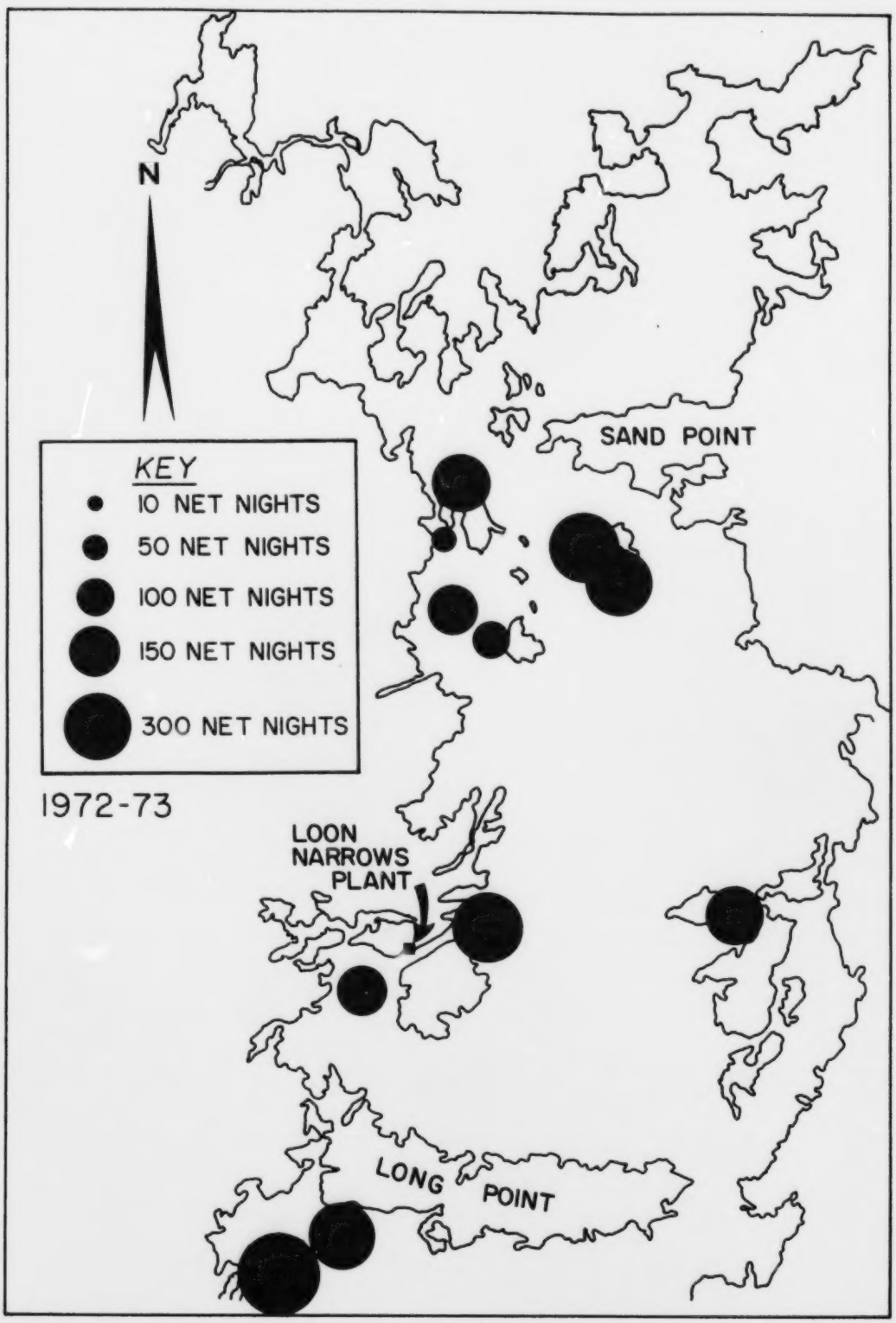

Fig. 2. Distribution of fishing effort (in net nights) for fishing enterprises landing fish at Loon Narrows packing plant, winter fishery, 1972-73. Data from Weagle and Baxter (1973).

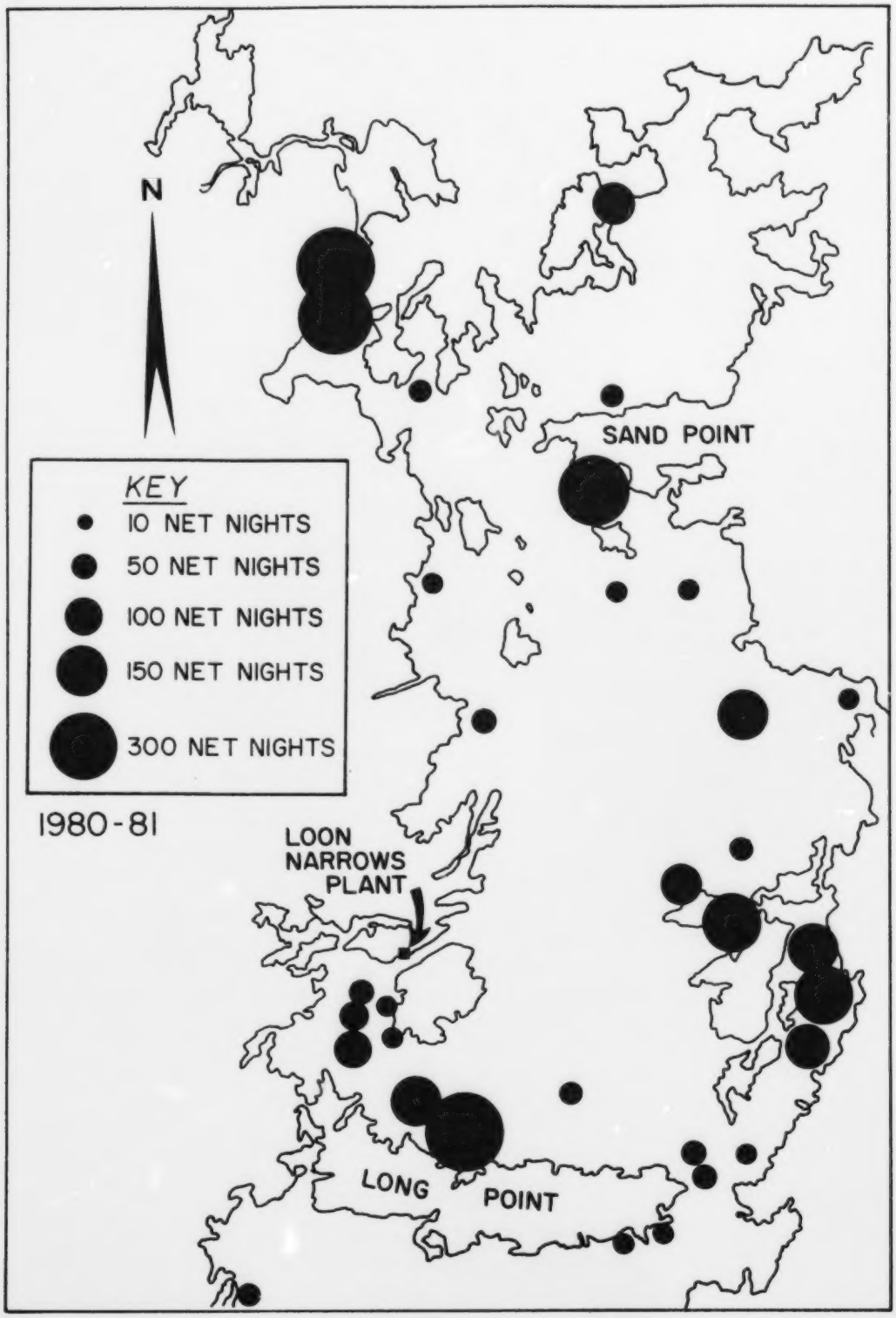

Fig. 3. Distribution of fishing effort (in net nights) for fishing enterprises landing fish at Loon Narrows packing plant, winter fishery, 1980-81.

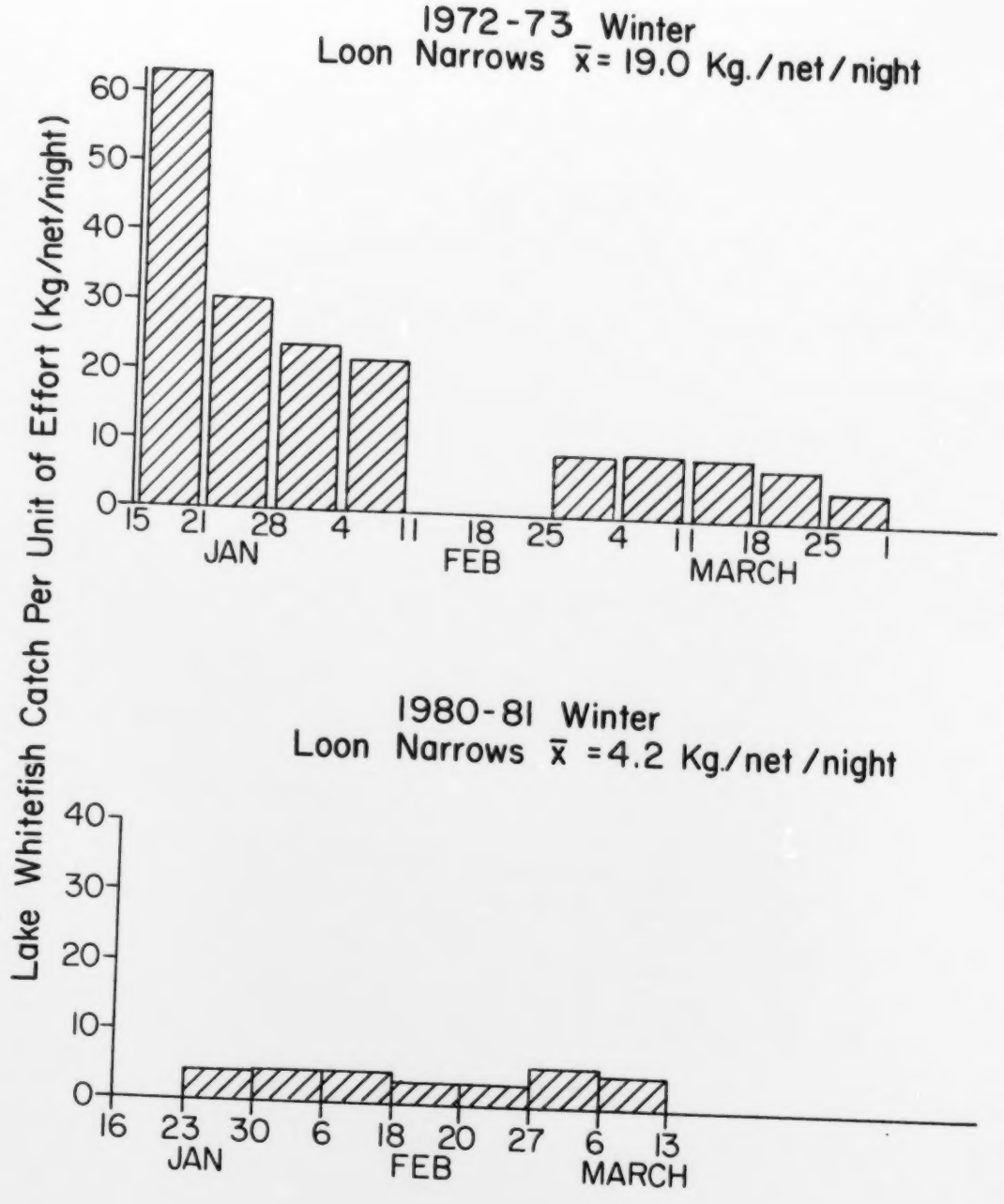

Fig. 4. Whitefish catch per unit of effort for fishing enterprises landing fish at Loon Narrows packing plant, winters of 1972-73 and 1980-81. Data for 1972-73 from Weagle and Baxter (1973).

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